

1      CLAIMS:

2      1. An isolation region forming method comprising:  
3                forming openings through first and second masking layers over a  
4                substrate, the second masking layer being over the first masking layer;  
5                after forming the openings, removing portions of the second  
6                masking layer while leaving some of the second masking layer remaining  
7                over the substrate; and  
8                after removing portions of the second masking layer, forming an  
9                insulative material within the etch openings, the insulative material within  
10               the etch openings forming at least portions of isolation regions.

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12      2. The method of claim 1 wherein the first masking layer  
13               comprises silicon dioxide and the second masking layer comprises silicon  
14               nitride.

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16      3. The method of claim 1 wherein the substrate comprises  
17               silicon and the forming insulative material comprises:  
18               thermally growing a first silicon dioxide layer from the substrate  
19               within the openings; and  
20               depositing a second silicon dioxide layer within the openings and  
21               over the first silicon dioxide layer.

1           4. The method of claim 1 wherein the removing portions of the  
2 second masking layer reduces a thickness of the second masking layer  
3 without moving a lateral periphery of the second masking layer outward  
4 from the opening.

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6           5. The method of claim 1 wherein the removing portions of the  
7 second masking layer moves a lateral periphery of the second masking  
8 layer outward from the opening without reducing a thickness of the  
9 second masking layer.

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11          6. The method of claim 1 wherein the removing portions of the  
12 second masking layer moves a lateral periphery of the second masking  
13 layer outward from the opening and reduces a thickness of the second  
14 masking layer.

1           7. The method of claim 1 further comprising forming a  
2         patterned layer of photoresist over the second masking layer before  
3         forming the openings through the first and second masking layers, the  
4         forming the openings through the first and second masking layers  
5         comprising transferring a pattern from the patterned photoresist to the  
6         first and second masking layers, at least some of the photoresist  
7         remaining over the second masking layer during the removing portions  
8         of the second masking layer.

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10          8. The method of claim 1 further comprising:  
11         forming a patterned layer of photoresist over the second masking  
12         layer before forming the openings through the first and second masking  
13         layers, the forming the openings through the first and second masking  
14         layers comprising transferring a pattern from the patterned photoresist  
15         to the first and second masking layers; and  
16         removing the photoresist from over the second masking layer prior  
17         to the removing portions of the second masking layer.

1           9. An isolation region forming method comprising:  
2           forming openings through first masking and second masking layers  
3           and into a substrate underlying the first and second masking layers, the  
4           second masking layer being over the first masking layer;  
5           removing portions of the second masking layer while leaving some  
6           of the second masking layer remaining over the substrate; and  
7           after removing portions of the second masking layer, thermally  
8           oxidizing the substrate within the openings to form an oxide layer within  
9           the openings, the oxide layer within the openings forming at least  
10          portions of isolation regions.

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12         10. The method of claim 9 wherein the first masking layer  
13         comprises silicon dioxide and the second masking layer comprises silicon  
14         nitride.

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16         11. The method of claim 9 wherein the substrate comprises  
17         silicon and further comprising depositing a second silicon dioxide layer  
18         within the openings and over the thermally grown oxide layer.

1           12. The method of claim 9 wherein the removing portions of the  
2 second masking layer reduces a thickness of the second masking layer  
3 without moving a lateral periphery of the second masking layer outward  
4 from the opening.

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6           13. The method of claim 9 wherein the removing portions of the  
7 second masking layer moves a lateral periphery of the second masking  
8 layer outward from the opening without reducing a thickness of the  
9 second masking layer.

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11          14. The method of claim 9 wherein the removing portions of the  
12 second masking layer moves a lateral periphery of the second masking  
13 layer outward from the opening and reduces a thickness of the second  
14 masking layer.

1           15. The method of claim 9 further comprising forming a  
2 patterned layer of photoresist over the second masking layer before  
3 forming the openings through the first and second masking layers, the  
4 forming the openings through the first and second masking layers  
5 comprising transferring a pattern from the patterned photoresist to the  
6 first and second masking layers, at least some of the photoresist  
7 remaining over the second masking layer during the removing portions  
8 of the second masking layer.

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10          16. The method of claim 9 further comprising:  
11           forming a patterned layer of photoresist over the second masking  
12 layer before forming the openings through the first and second masking  
13 layers, the forming the openings through the first and second masking  
14 layers comprising transferring a pattern from the patterned photoresist  
15 to the first and second masking layers; and  
16           removing the photoresist from over the second masking layer prior  
17 to the removing portions of the second masking layer.

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1           17. An isolation region forming method comprising:  
2                 forming a first masking layer over a substrate;  
3                 forming a second masking layer over the first masking layer, the  
4                 first and second masking layers having a pattern of openings extending  
5                 therethrough to expose portions of the underlying substrate;  
6                 etching the exposed portions of the underlying substrate to form  
7                 openings extending into the substrate;  
8                 after etching the exposed portions of the underlying substrate,  
9                 removing portions of the second masking layer while leaving some of the  
10                 second masking layer remaining over the substrate; and  
11                 after removing portions of the second masking layer, forming an  
12                 insulative material within the openings in the substrate, the insulative  
13                 material within the openings forming at least portions of isolation  
14                 regions.

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16           18. The method of claim 17 wherein the first masking layer  
17                 comprises silicon dioxide and the second masking layer comprises silicon  
18                 nitride.

1        19. The method of claim 17 wherein the second masking layer  
2        comprises lateral sidewalls along the openings extending through the  
3        second masking layer, and wherein the removing portions of the second  
4        masking layer displaces the lateral sidewalls away from the openings.

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6        20. The method of claim 17 wherein the second masking layer  
7        comprises a thickness over the first masking layer, and wherein the  
8        removing portions of the second masking layer reduces the thickness of  
9        at least some of the remaining second masking layer.

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11        21. The method of claim 17 wherein the second masking layer  
12        comprises a thickness over the first masking layer, and wherein the  
13        removing portions of the second masking layer reduces the thickness of  
14        an entirety of the remaining second masking layer.

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16        22. The method of claim 17 wherein the removing portions of  
17        the second masking layer comprises facet etching the second masking  
18        layer.

1           23. The method of claim 17 further comprising:  
2           after removing portions of the second masking layer, etching the  
3           substrate to extend the openings formed in the substrate further into the  
4           substrate.

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6           24. An isolation region forming method comprising:  
7           forming a masking layer over a substrate;  
8           forming a pattern of openings extending through the masking layer  
9           and into the underlying substrate;  
10          after forming the openings, facet etching the first masking layer;  
11          and  
12          after the facet etching, forming insulative material within the  
13          openings extended into the substrate, the insulative material within the  
14          openings forming at least portions of isolation regions.

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16          25. The method of claim 24 wherein the masking layer comprises  
17          silicon nitride.

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1           26. The method of claim 24 wherein the substrate comprises  
2         silicon and the forming insulative material comprises:

3             thermally growing a first silicon dioxide layer from the substrate  
4         within the openings; and

5             depositing a second silicon dioxide layer within the openings and  
6         over the first silicon dioxide layer.

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8           27. An isolation region forming method comprising:

9             forming a masking layer over a substrate;

10           forming a pattern of openings extending through the masking layer  
11         and into the underlying substrate, the first masking layer having edge  
12         regions proximate the openings and having a central region between the  
13         edge regions;

14           after extending the openings into the underlying substrate, reducing  
15         a thickness of the first layer at the edge regions to thin the edge  
16         regions relative to the central region; and

17           forming insulative material within the openings extended into the  
18         substrate, the insulative material within the openings forming at least  
19         portions of isolation regions.

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21           28. The method of claim 27 wherein the masking layer comprises  
22         silicon nitride.

1           29. The method of claim 27 wherein the substrate comprises  
2         silicon and the forming insulative material comprises:

3                 thermally growing a first silicon dioxide layer from the substrate  
4         within the openings; and

5                 depositing a second silicon dioxide layer within the openings and  
6         over the first silicon dioxide layer.

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8           30. The method of claim 27 further comprising forming a  
9         patterned photoresist layer over the masking layer, and wherein the  
10       forming openings comprises transferring a pattern from the patterned  
11       photoresist layer to the masking layer, the reducing the thickness of the  
12       silicon nitride layer at the edge regions comprising:

13                 removing a portion of the photoresist overlying the masking layer  
14         edge regions while leaving another portion of the photoresist overlying  
15         the masking layer central region; and

16                 after removing the portion of the photoresist, and while said other  
17         portion of the photoresist is over the masking layer central region,  
18         exposing the masking layer to etching conditions which reduce the  
19         thickness of the masking layer at the edge regions.

1           31. An isolation region forming method comprising:  
2           forming a silicon nitride layer over a substrate, the silicon nitride  
3           layer having a pattern of openings extending therethrough to expose  
4           portions of the underlying substrate;  
5           etching the exposed portions of the underlying substrate to form  
6           openings extending into the substrate;  
7           after etching the exposed portions of the underlying substrate, wet  
8           etching the silicon nitride layer to remove portions of the silicon nitride  
9           layer while leaving other portions of the silicon nitride layer over the  
10          substrate; and  
11          after the wet etching, forming oxide within the openings in the  
12          substrate, the oxide within the openings forming at least portions of  
13          isolation regions.

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15          32. The method of claim 31 further comprising:  
16          forming a silicon oxide layer over the substrate; and  
17          the forming the silicon nitride layer comprising forming the silicon  
18          nitride layer over the silicon oxide layer.

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20          33. The method of claim 31 wherein said other portions of the  
21          silicon nitride layer have a thickness of at least about 600Å after the  
22          wet etching.

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2       34. The method of claim 31 the wet etching comprises exposing  
the silicon nitride layer to phosphoric acid.  
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1           35. An isolation region forming method comprising:  
2           forming a silicon nitride layer over a substrate;  
3           forming a masking layer over the silicon nitride layer;  
4           forming a pattern of openings extending through the masking layer  
5           to the silicon nitride layer;  
6           extending the openings through the silicon nitride layer to the  
7           underlying substrate with a first etch, the silicon nitride layer comprising  
8           edge regions proximate the openings and having a central region between  
9           the edge regions;  
10          extending the openings into the underlying substrate with a second  
11         etch, the second etch forming a polymer over the edge regions;  
12          after extending the openings into the underlying substrate, exposing  
13         the silicon nitride layer and masking layer to dry etching conditions to  
14         remove the polymer from the edges of the silicon nitride layer and to  
15         remove portions of the masking layer while leaving other portions of the  
16         masking layer remaining over the silicon nitride layer;  
17          after the dry etching, further extending the openings into the  
18         substrate; and  
19          after the further extending, forming oxide within the openings in  
20         the substrate, the oxide within the openings forming at least portions of  
21         isolation regions.

1           36. The method of claim 35 wherein the second etch comprises  
2 different conditions than the first etch.

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4           37. The method of claim 35 wherein the second etch comprises  
5 a dry plasma etch utilizing CF<sub>4</sub>/HBr and the first etch comprises a dry  
6 plasma etch utilizing at least one of CF<sub>4</sub> and CH<sub>2</sub>F<sub>2</sub>.

7           ~~7~~  
8           38. The method of claim 35 further comprising:  
9           forming a silicon oxide layer over the substrate; and  
10           the forming the silicon nitride layer comprising forming the silicon  
11           nitride layer over the silicon oxide layer.

12           ~~12~~  
13           39. The method of claim 35 wherein the dry etching comprises  
14           exposing the silicon nitride layer and masking layer to an oxygen-  
15           containing gas.

16           ~~16~~  
17           40. The method of claim 35 wherein the masking layer comprises  
18           photoresist and the dry etching comprises exposing the silicon nitride  
19           layer and masking layer to an oxygen-containing gas.

20           ~~20~~  
21           41. The method of claim 35 wherein the dry etching comprises  
22           exposing the silicon nitride layer and masking layer to O<sub>2</sub>.

1           42. An isolation region forming method comprising:  
2           forming a silicon nitride layer over a substrate;  
3           forming a masking layer over the silicon nitride layer;  
4           forming a pattern of openings extending through the masking layer  
5           to the silicon nitride layer;  
6           extending the openings through the silicon nitride layer to the  
7           underlying substrate, the silicon nitride layer having edge regions  
8           proximate the openings and having a central region between the edge  
9           regions;  
10          extending the openings into the underlying substrate;  
11          after extending the openings into the underlying substrate, reducing  
12         a thickness of the silicon nitride layer at the edge regions to thin the  
13         edge regions relative to the central region; and  
14          forming oxide within the openings extended into the substrate, the  
15         oxide within the openings forming at least portions of isolation regions.

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17          43. The method of claim 42 further comprising forming a silicon  
18         oxide layer over the substrate, the forming the silicon nitride layer  
19         comprising forming the silicon nitride layer over the silicon oxide layer.

1           44. The method of claim 42 wherein a thickness of the central  
2 region is substantially unchanged as the thickness of the edge regions is  
3 reduced.

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5           45. The method of claim 42 wherein the reducing the thickness  
6 of the silicon nitride layer at the edge regions comprises:

7                 removing a portion of the masking layer overlying the silicon  
8 nitride layer edge regions while leaving another portion of the masking  
9 layer overlying the silicon nitride central region; and

10                 after removing the portion of the masking layer, and while said  
11 other portion of the masking layer is over the silicon nitride central  
12 region, exposing the silicon nitride layer to etching conditions which  
13 reduce the thickness of the silicon nitride layer at the edge regions.

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15           46. The method of claim 45 wherein the etching conditions  
16 anisotropically etch the silicon nitride layer.

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18           47. The method of claim 42 wherein the reducing the thickness  
19 of the silicon nitride layer at the edge regions comprises:

20                 removing the masking layer; and

21                 facet etching the silicon nitride layer to form faceted edges at the  
22 edge regions.

1           48. The method of claim 42 further comprising:  
2           forming a silicon oxide layer over the substrate;  
3           the forming the silicon nitride layer comprising forming the silicon  
4           nitride layer over the silicon oxide layer;  
5           after forming the silicon nitride layer and extending the openings  
6           into the underlying substrate, removing a portion of the silicon oxide  
7           layer underlying the silicon nitride layer edge regions to undercut the  
8           edge regions; and  
9           the reducing the thickness of the silicon nitride layer at the edge  
10          regions comprising:  
11           removing the masking layer; and  
12           facet etching the silicon nitride layer to form faceted edges  
13          at the edge regions.

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